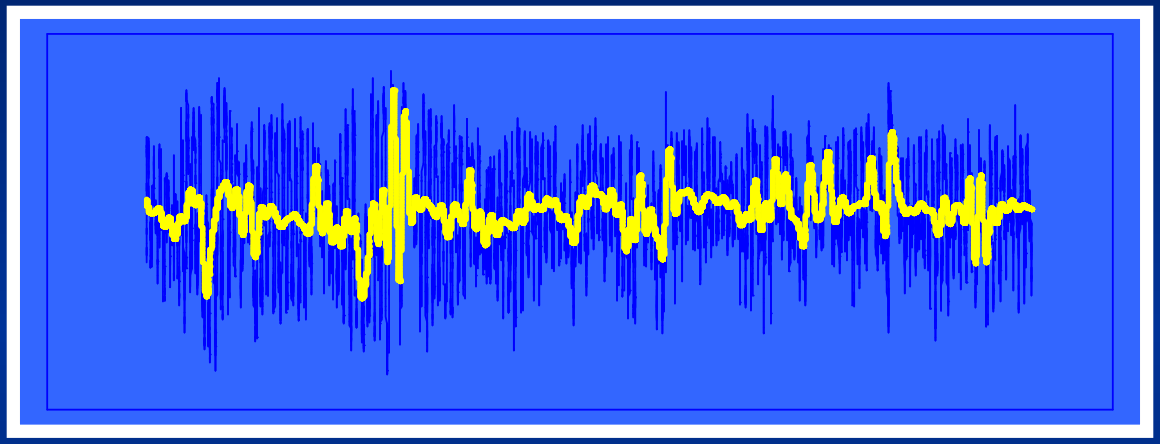
Hydroacoustics and the USGS



D. Phil Turnipseed, P.E.

Joint USACE-USGS Meeting

USGS National Center
Reston, Virginia
November 29, 2006

U.S. Department of the Interior
U.S. Geological Survey

USGS

Issues

- **Increasing coastal population**
- **Freshwater outflows to the Atlantic, the Pacific and the Gulf of Mexico**
- **Operation and maintenance of dams and floodways**
- **Coastal Restoration**

USGS

Historical roadblock

Unsteady (varied, non-uniform) open channel flow

USGS

Agenda

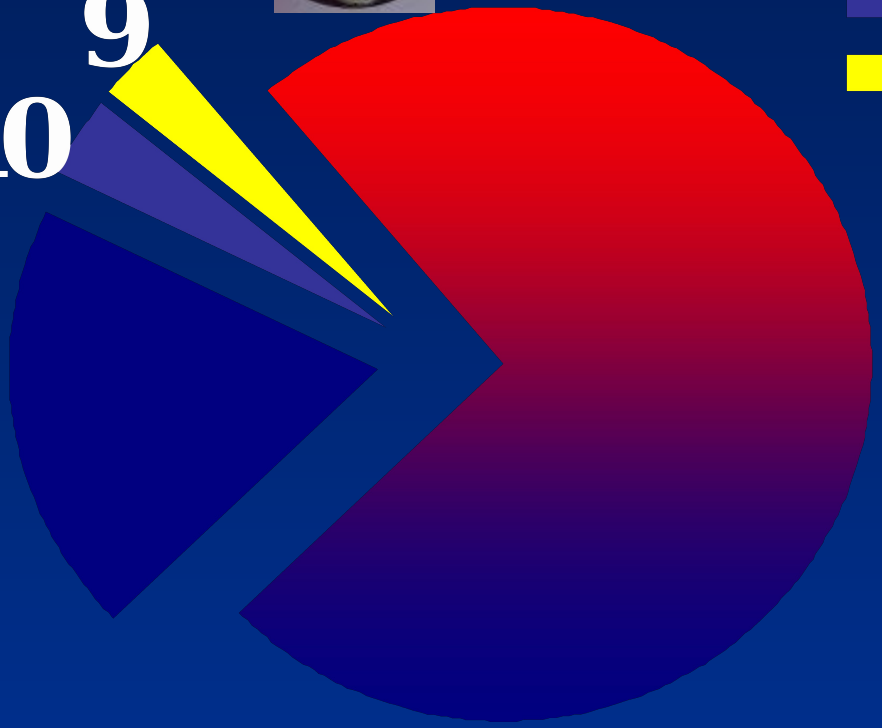
- **Acoustic Doppler Current Profilers (ADCPs) and the USGS**
- **Index Velocity**
- **New developments in hydroacoustics**
- **Quality Assurance**

USGS

Acoustic Doppler Current Profilers (ADCPs)

USGS

ADCPs Used in the USGS for Streamflow Measurement



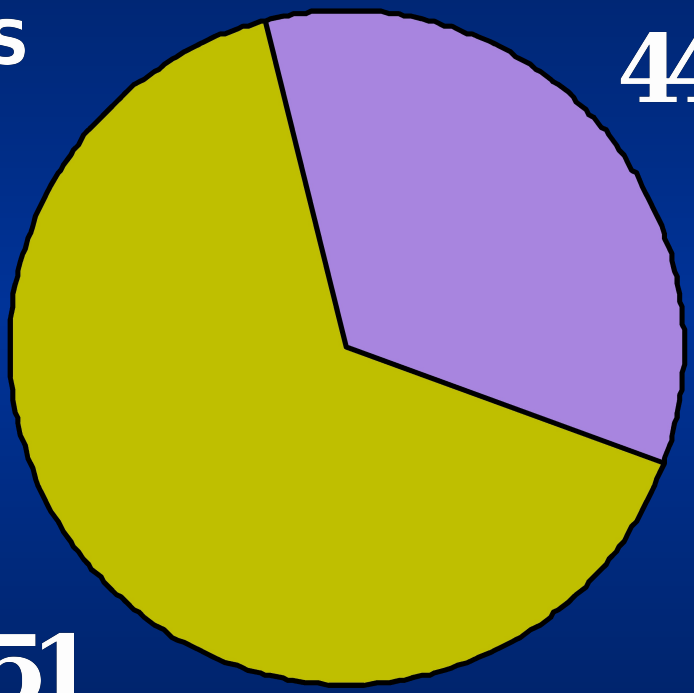
RDI Rio Grande
RDI StreamPro
Nortek BoogieDopp
Sontek ADP

Updated July 2006

USGS

11.9% (3,522) of discharge measurements from Oct 1, 2005 to April 15, 2006

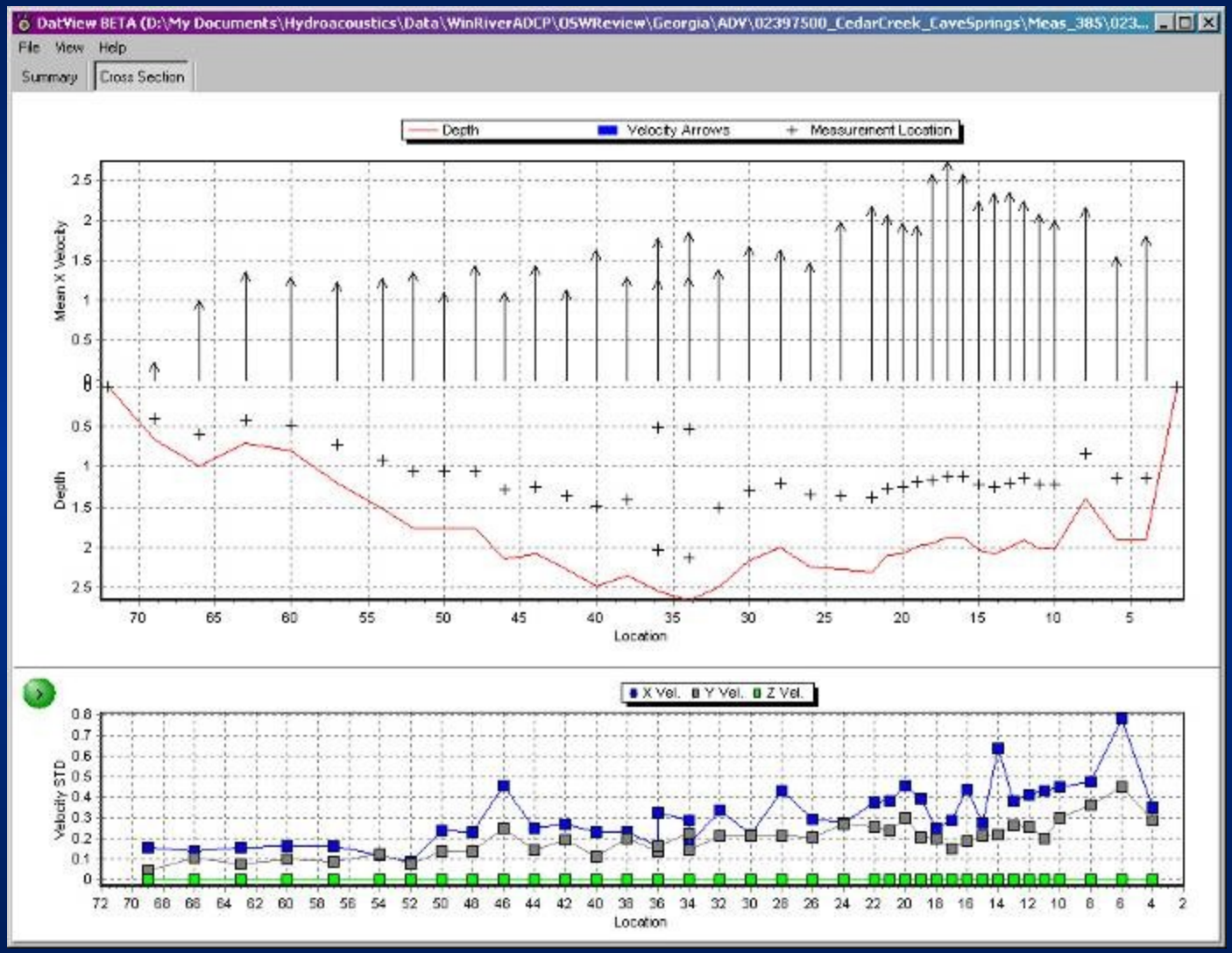
FlowTracker Use



17.6% (5,244) of discharge measurements from Oct 1, 2005 to April 15, 2006

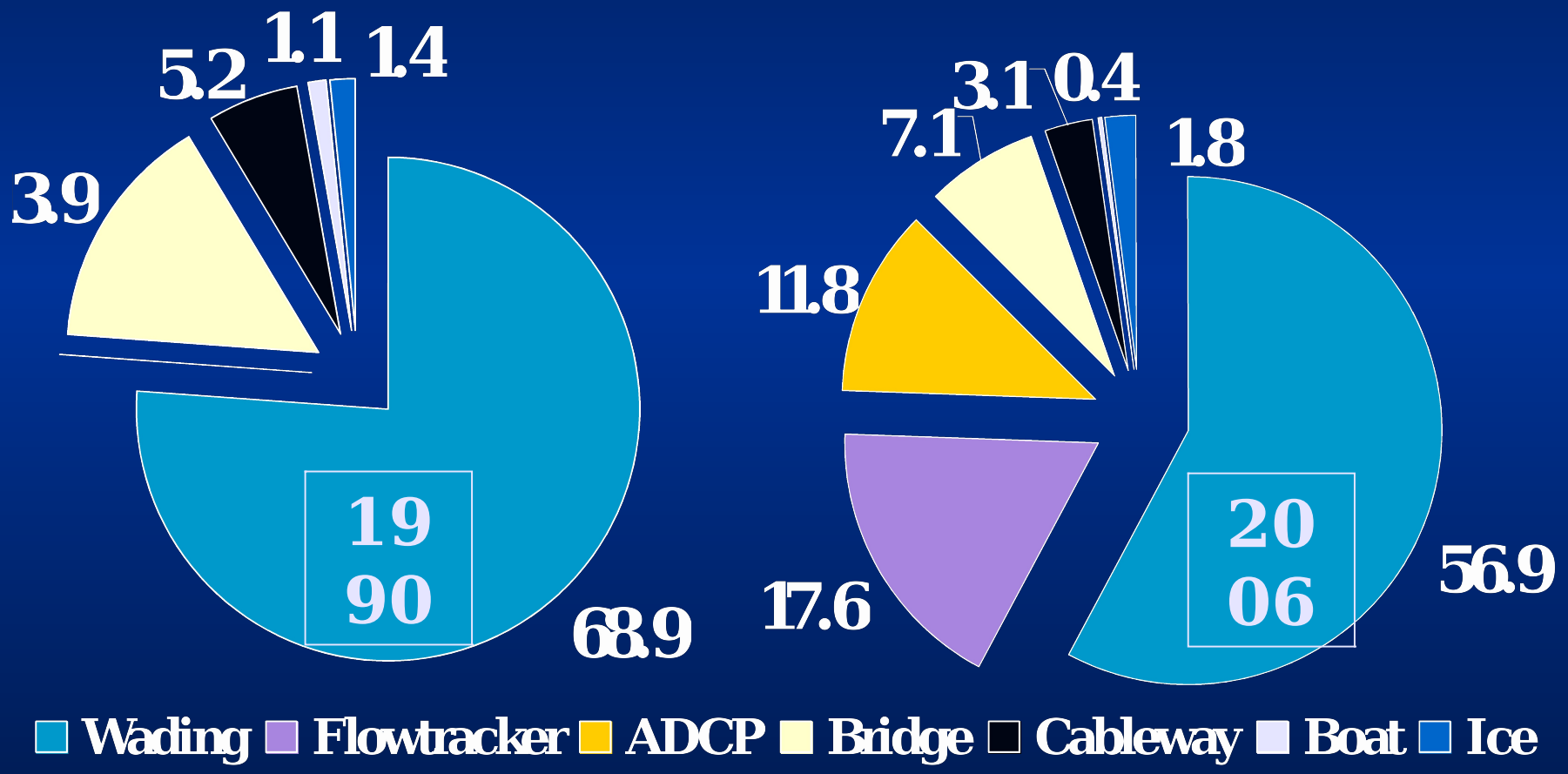
USGS

FlowTracker Data Review



USGS

29% of USGS Qm's made with Hydroacoustic Instruments in 2006!



USGS

Flood Measurements Using ADCPs

- **January 1991 flood** (Current Meters)
  - 52 Discharge Measurements in 10 days
  - Average Qm time -- 96 minutes
  - 11 hydrographers
- **July 2003 flood** (ADCPs)
  - 62 Discharge Measurements in 10 days
  - Average Qm time -- 18 minutes
  - 6 hydrographers

USGS

Index Velocity

USGS

Conventional Stage-Discharge Rating Empirical Relationship:

$$GH = Q$$

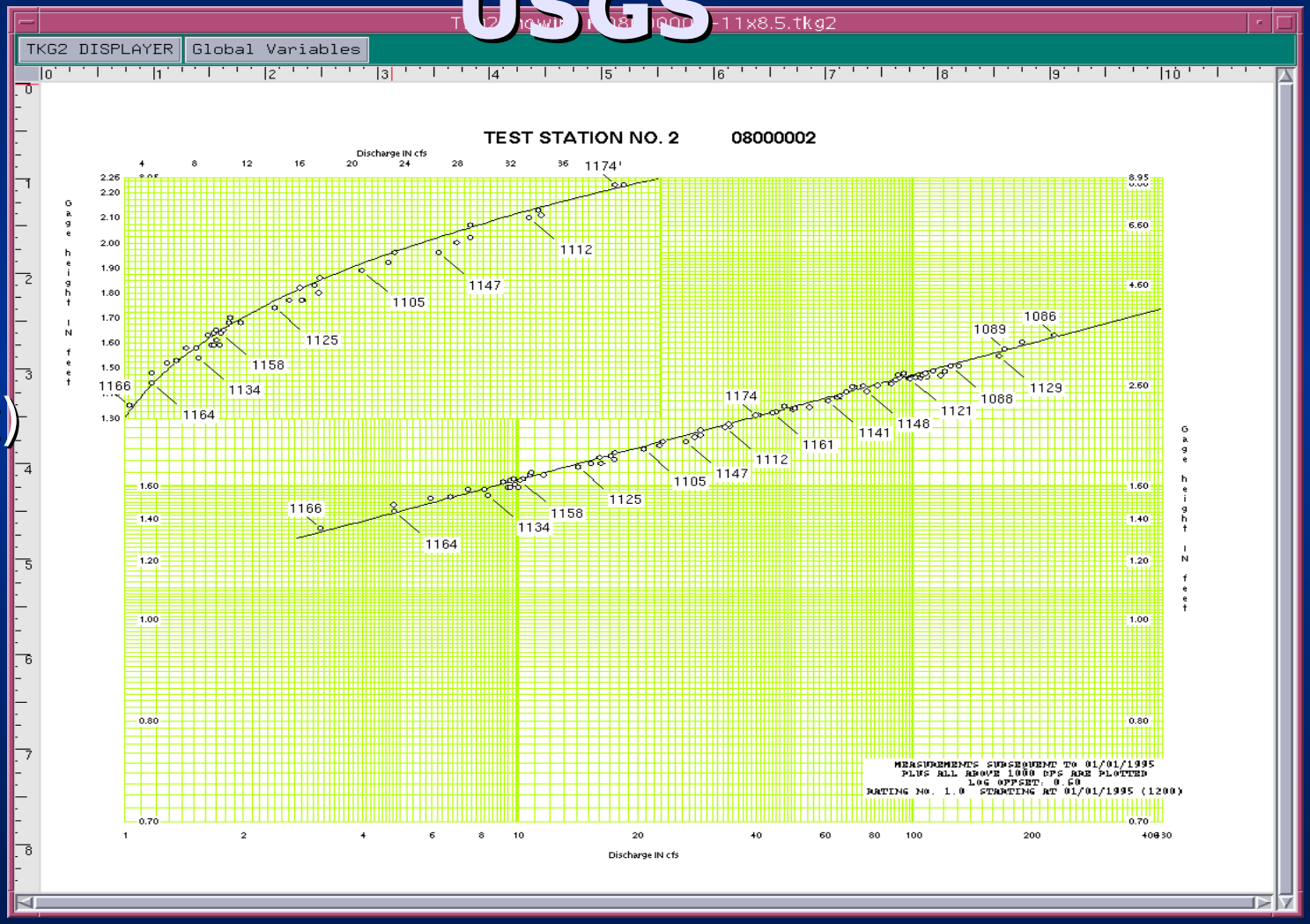
Where for a given channel cross-section:

Q **= discharge in ft³/s;**

GH **= river stage in ft;**

USGS

Conventional Stage-Discharge Ratings of the USGS


TKG2 DISPLAYER
Global Variables
TEST STATION NO. 2 08000002
Discharge IN cfs
Gage height IN feet
MEASUREMENTS SUBSEQUENT TO 01/01/1995
PLUS ALL ABOVE 1000 CFS ARE PLOTTED
LOG OFFSET: 0.50
RATING NO. 1.0 STARTING AT 01/01/1995 (1200)

Stage (feet)

Discharge (cubic feet per second)

Continuity Equation:

$$Q = VA$$

Where for a given channel cross-section:

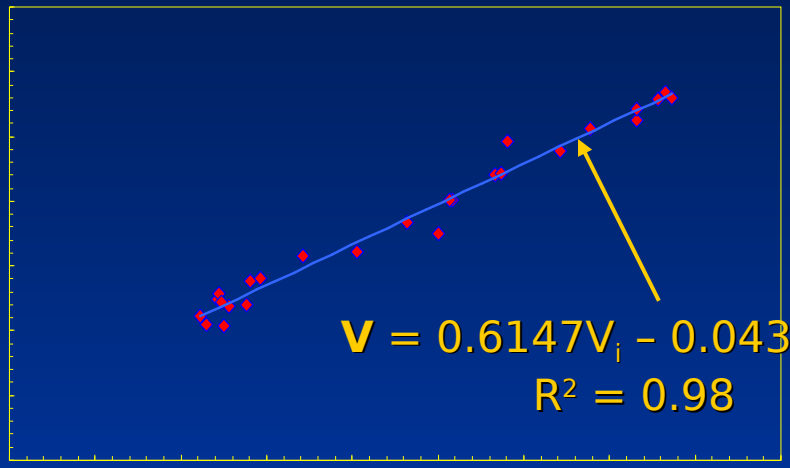
Q **= discharge in ft³/s;**

V **= the average velocity in ft/s;**

A **= cross sectional area in ft²**

USGS

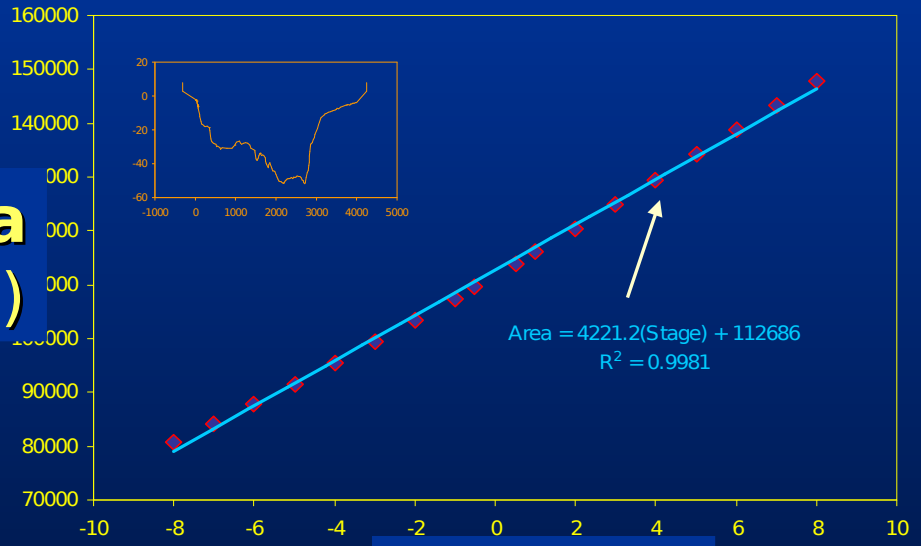
Average velocity (V) / ADVM velocity relation



V (ft/s)

V_i (ft/s)

Cross-sectional area (*A*) computation

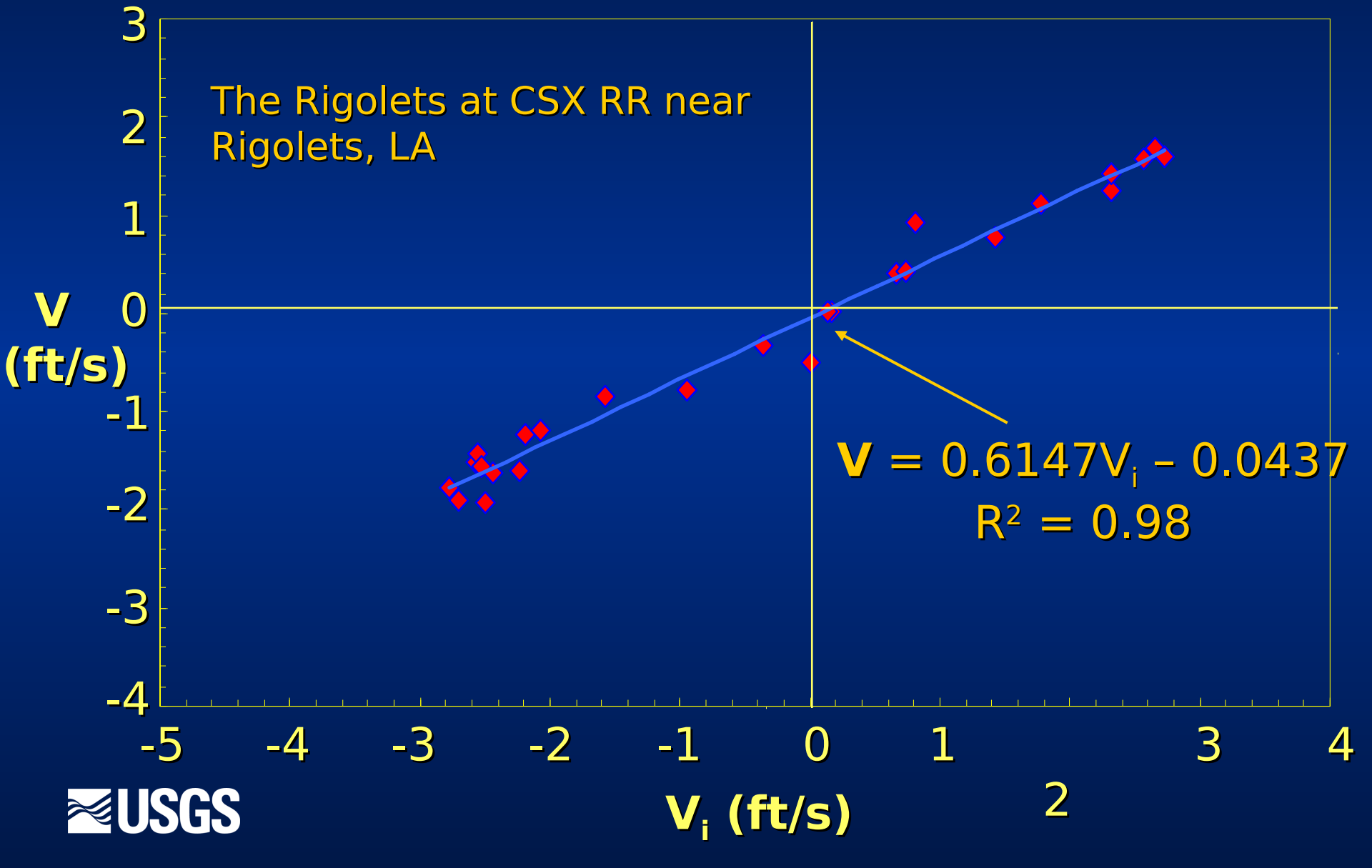


Area (sq.ft.)

Stage(ft)

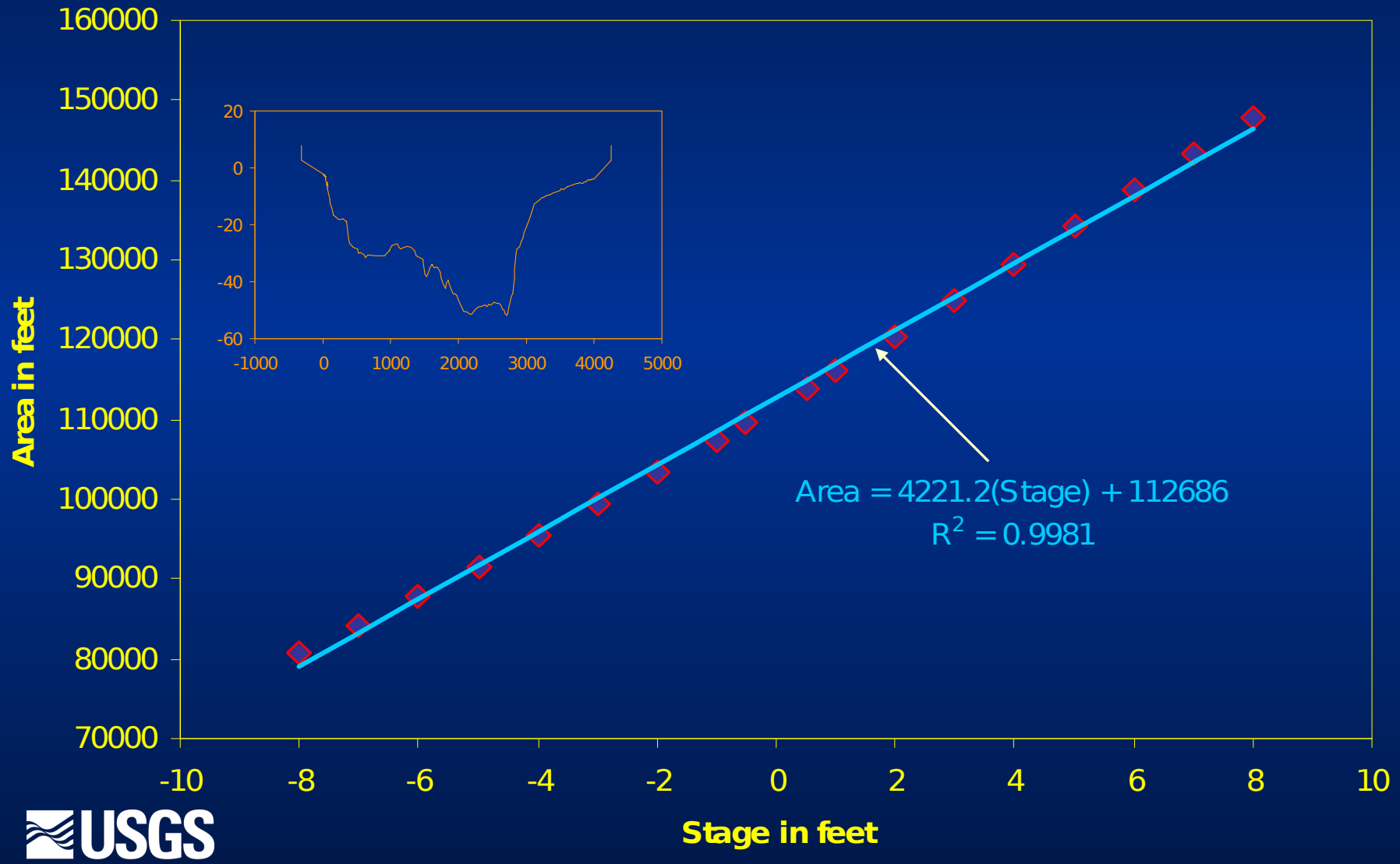
USGS

Average velocity (V) / ADVM velocity relation



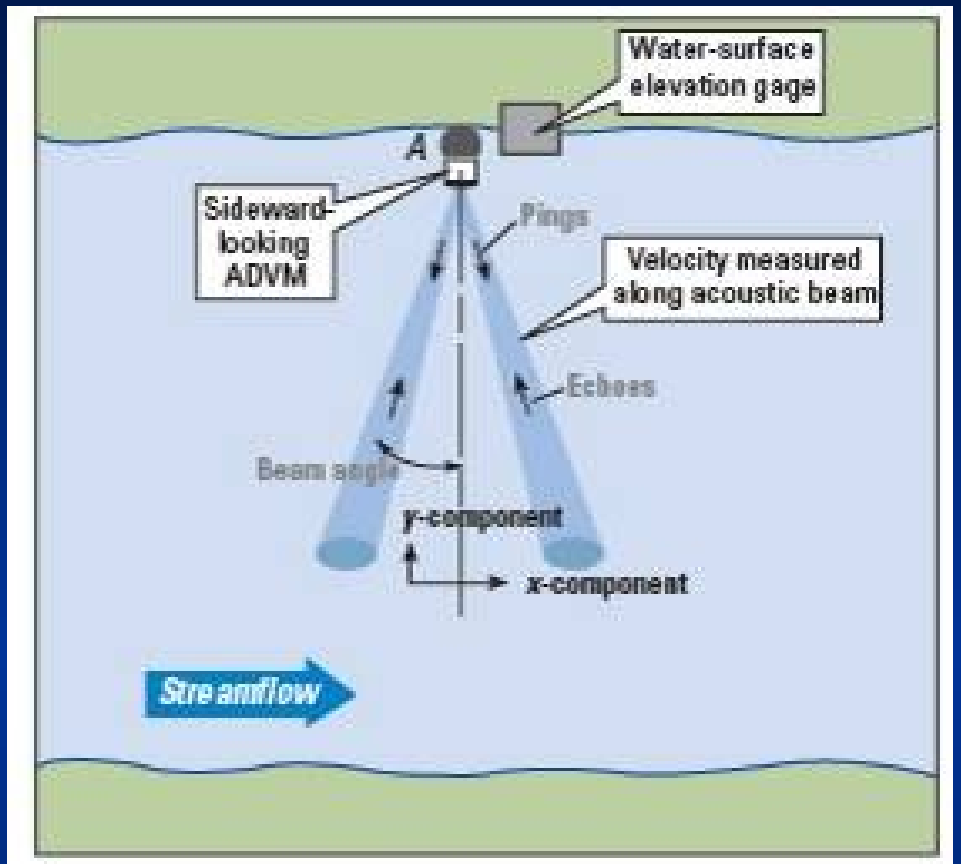
USGS

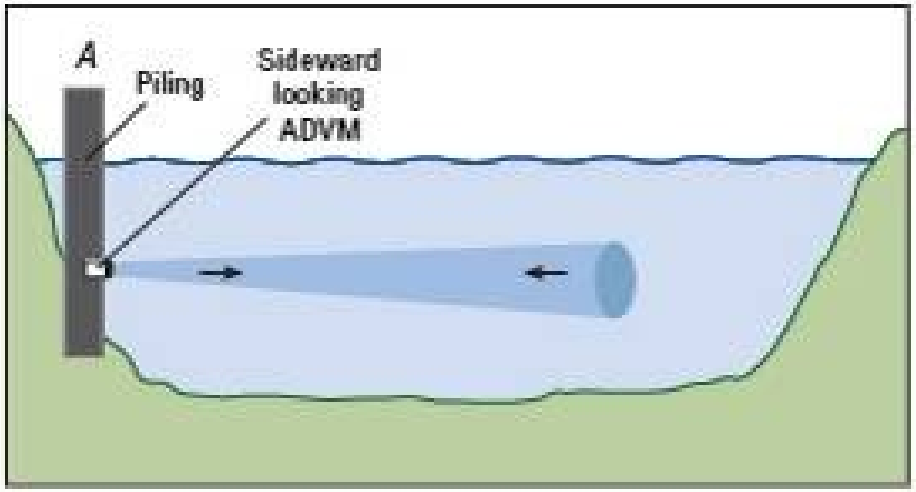
Cross-sectional area (*A*) computation



USGS

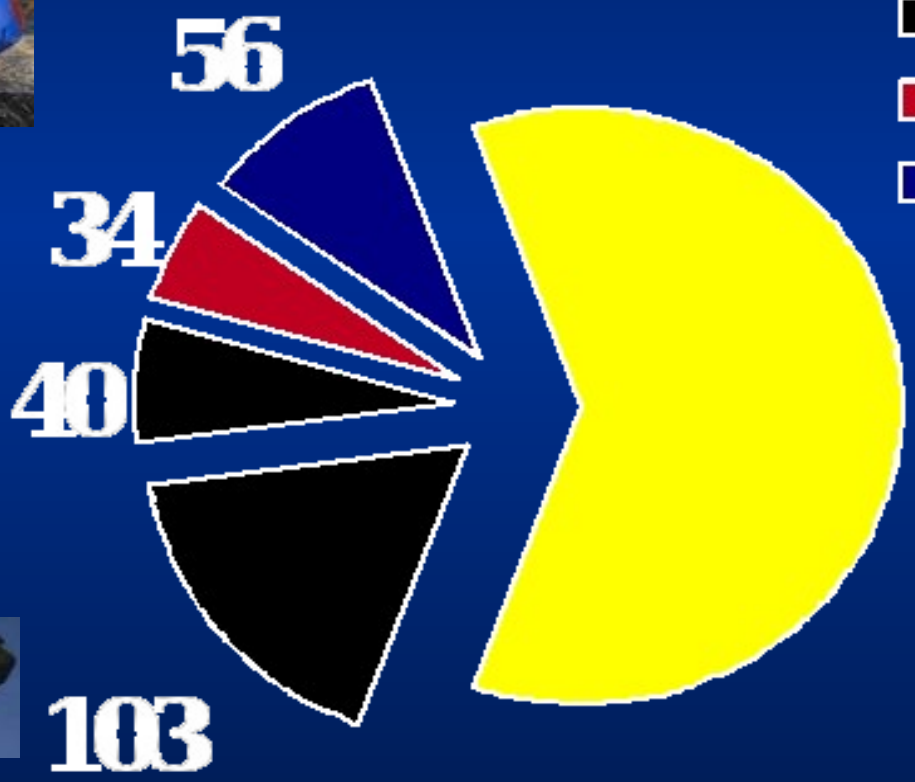
Index Velocity Meters





USGS

Index-Velocity Instruments

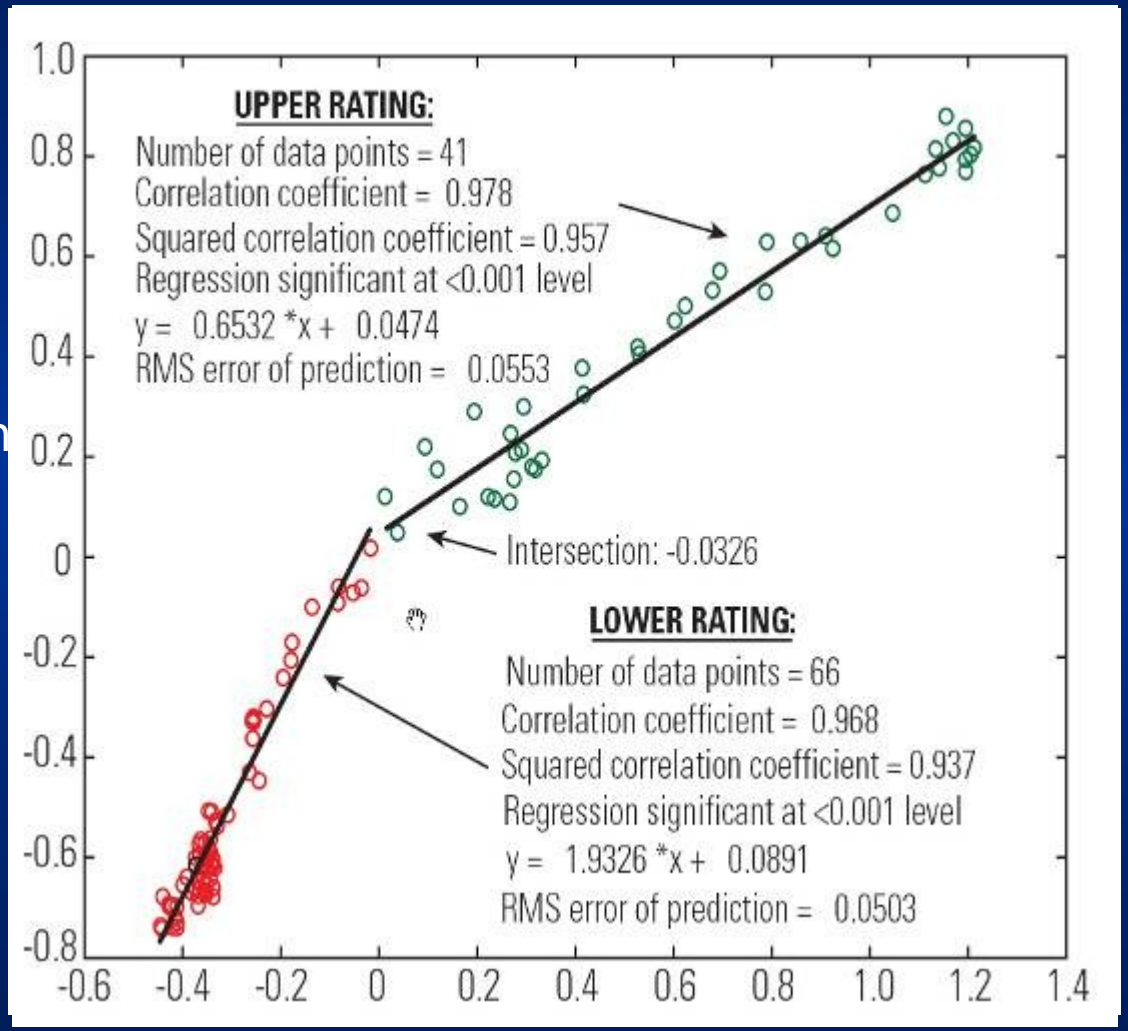


USGS

Updated July 2006

Index Velocity Ratings

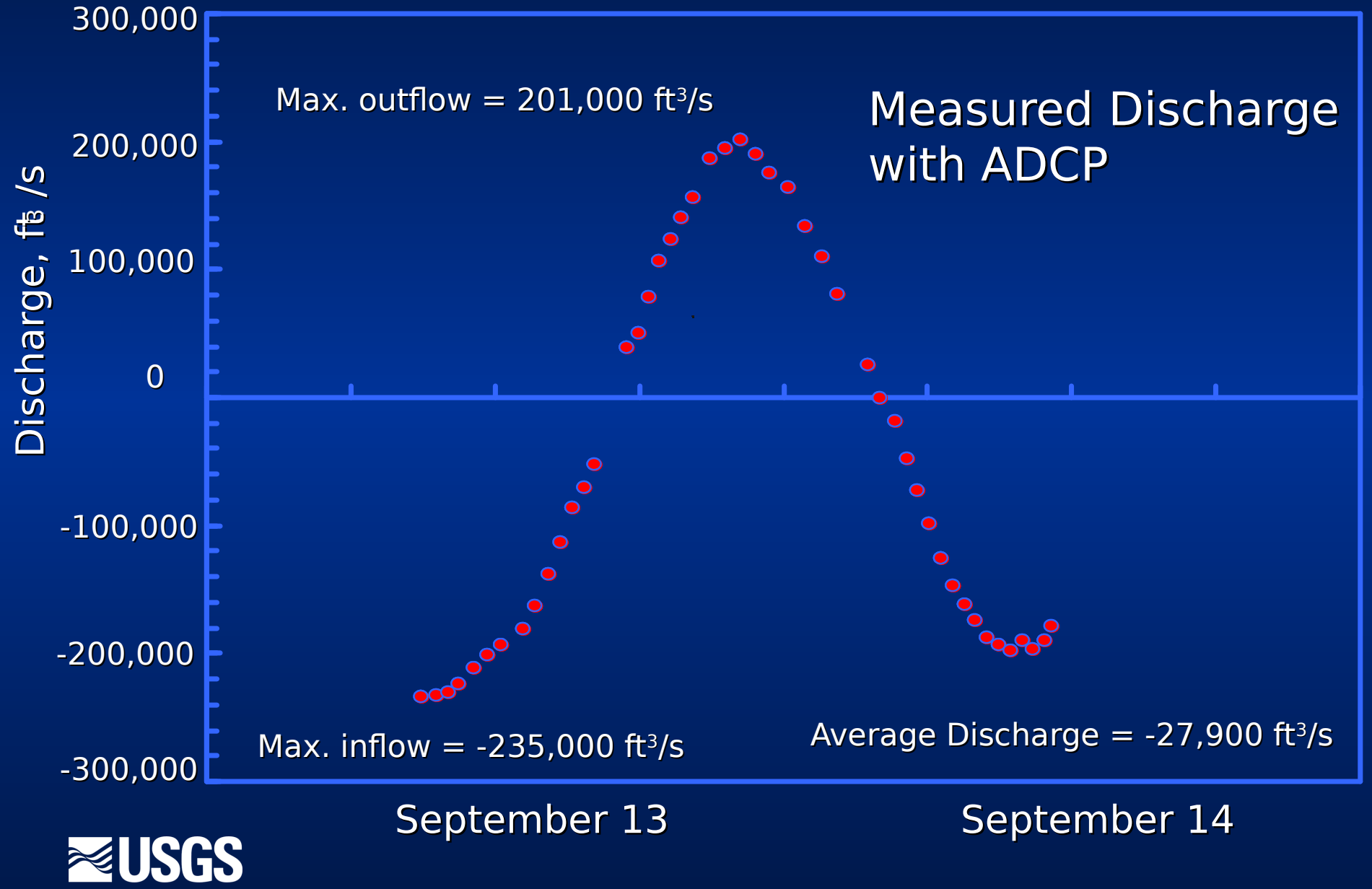
Ave. Velocity (ft/s) from Qm



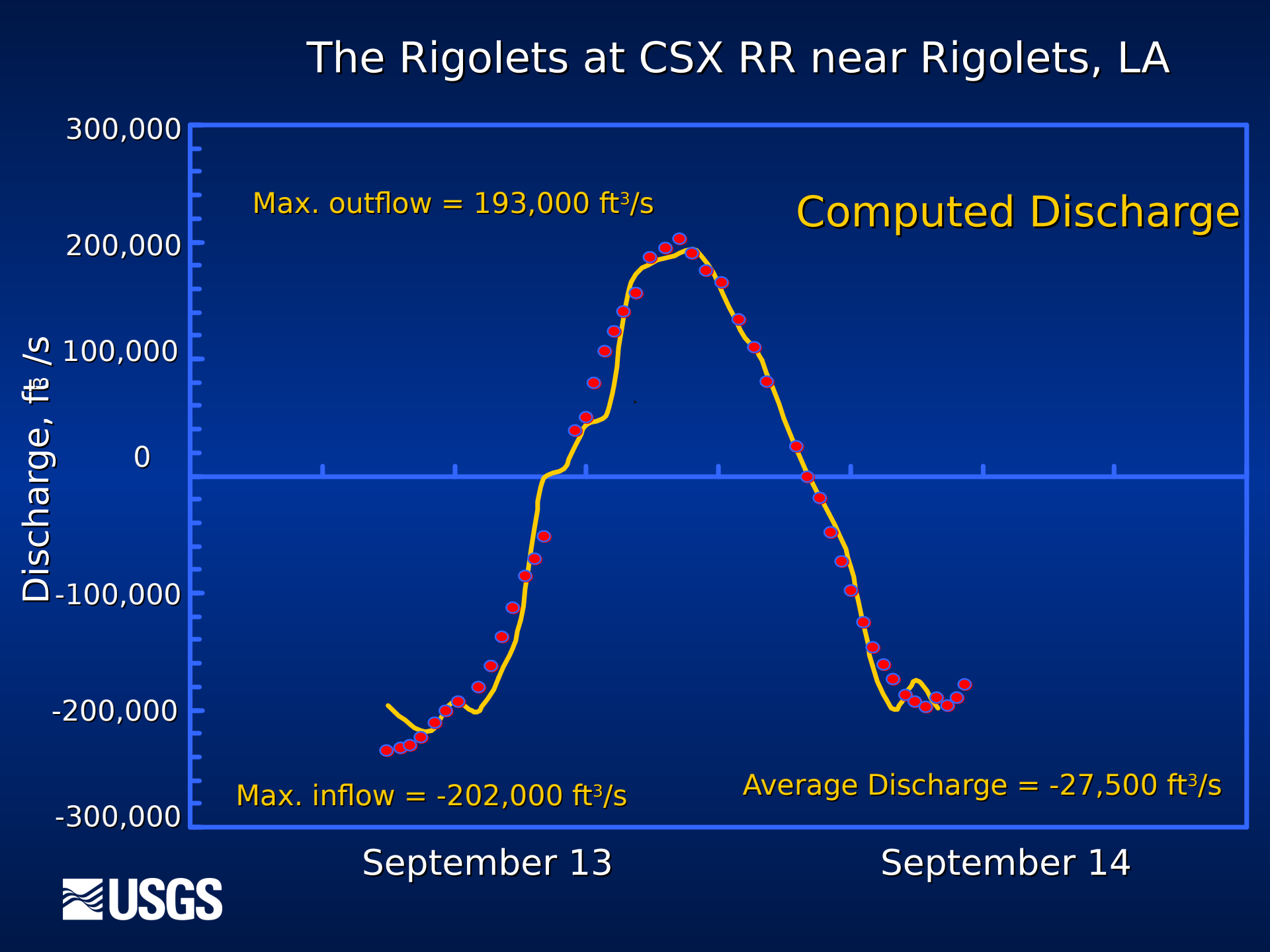
USGS

Instantaneous Velocity (ft/s)

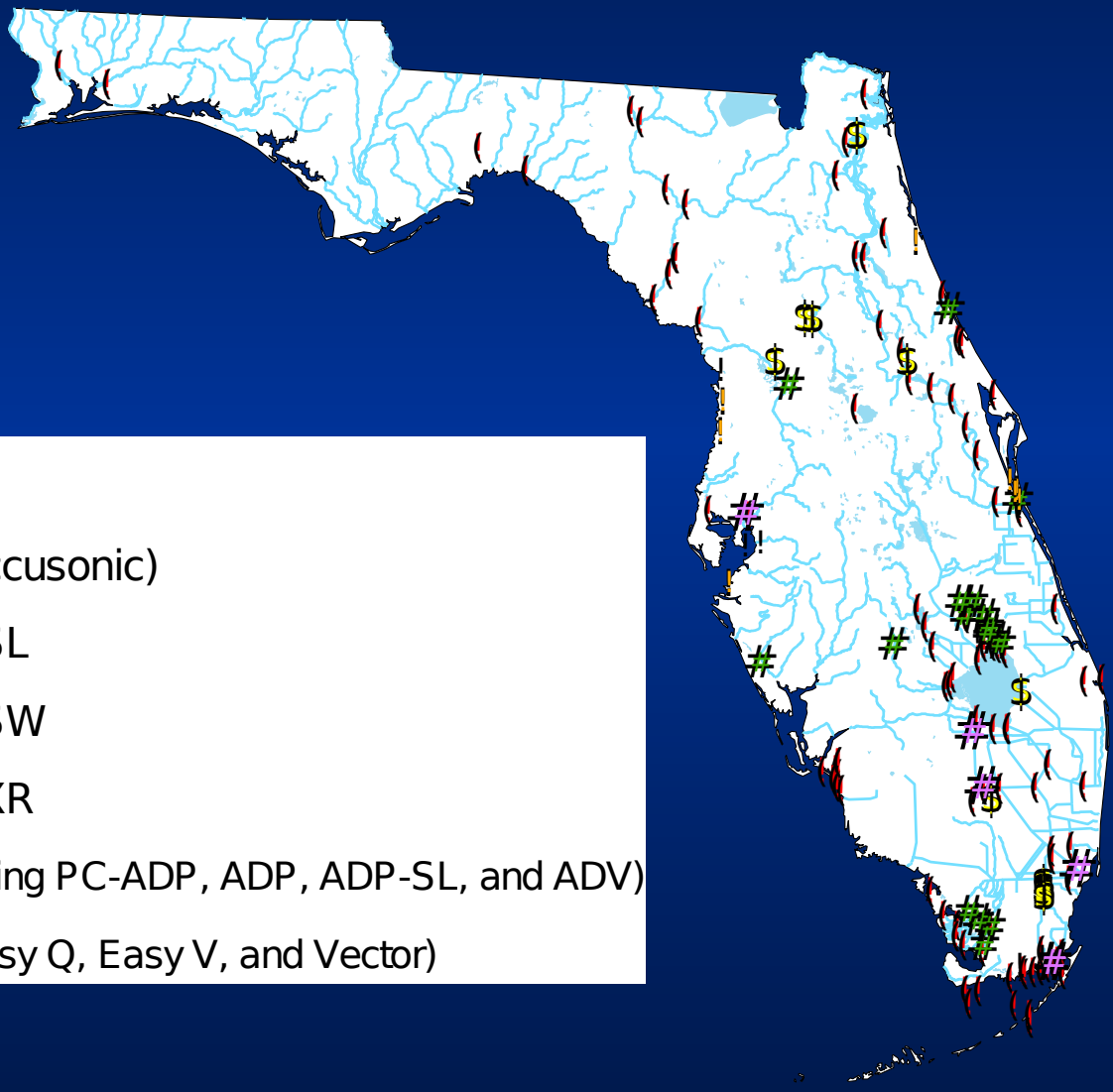
The Rigolets at CSX RR near Rigolets, LA



USGS


The Rigolets at CSX RR near Rigolets, LA
300,000
200,000
100,000
0
-100,000
-200,000
-300,000
Discharge, ft3/s
Max. outflow = 193,000 ft3/s
Computed Discharge
Max. inflow = -202,000 ft3/s
Average Discharge = -27,500 ft3/s
September 13
September 14
USGS

Florida In-situ Hydroacoustic Deployments

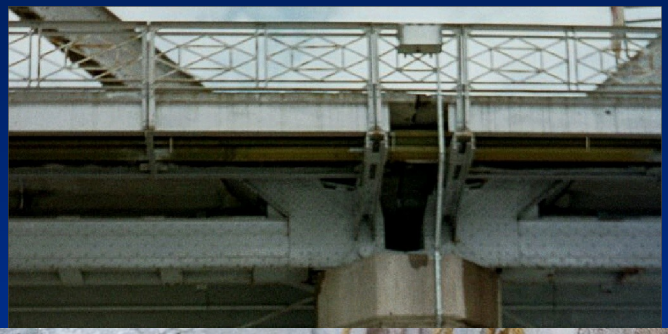


Legend

$	AVM (Affra and Accusonic)
(	Sontek Argonaut SL
#	Sontek Argonaut SW
!	Sontek Argonaut XR
!	other Sontek (including PC-ADP, ADP, ADP-SL, and ADV)
#	Nortek (including Easy Q, Easy V, and Vector)

USGS

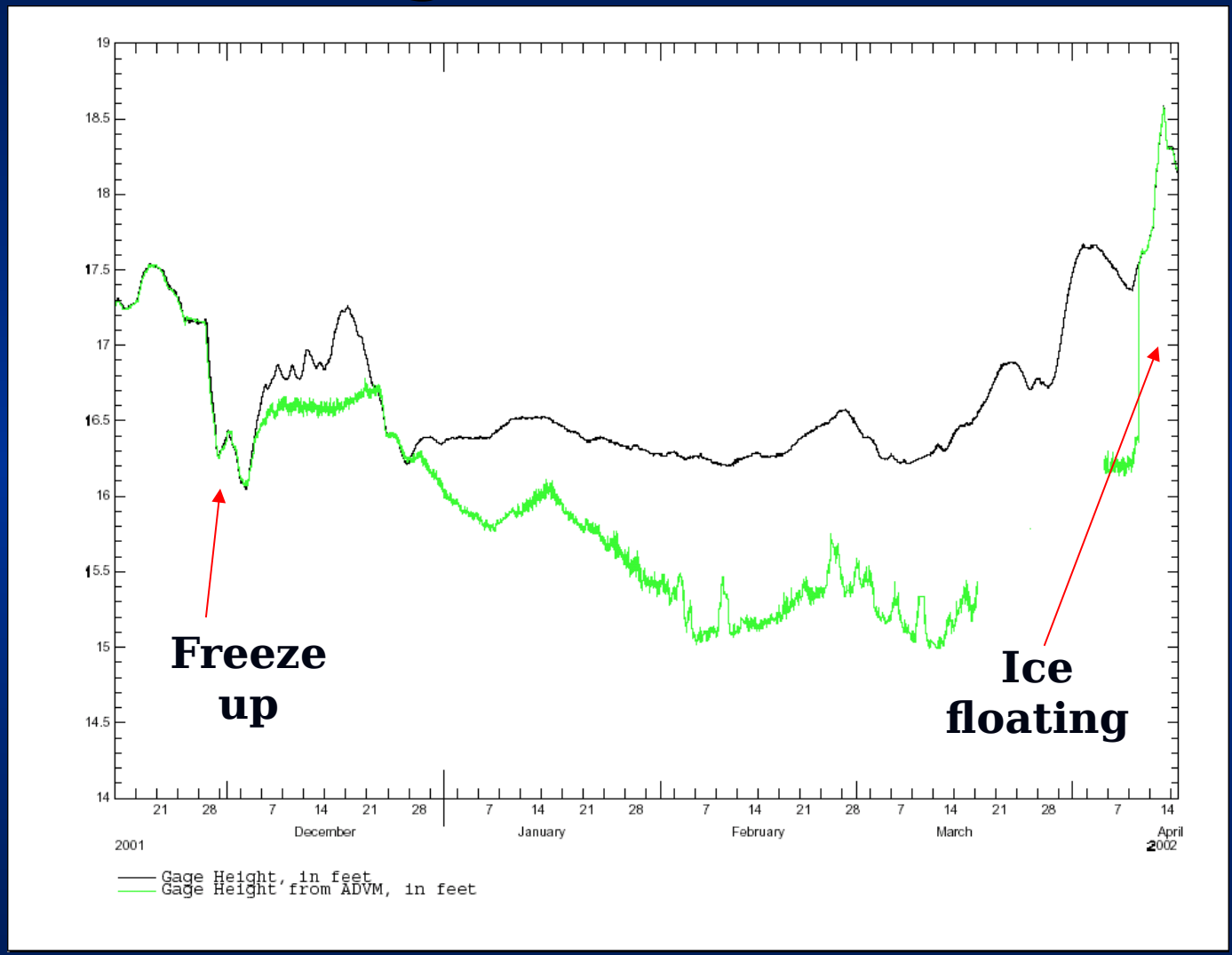
Measurement of Flow under Ice



USGS

Pressure Transducer Stage and Acoustic Stage Measurement

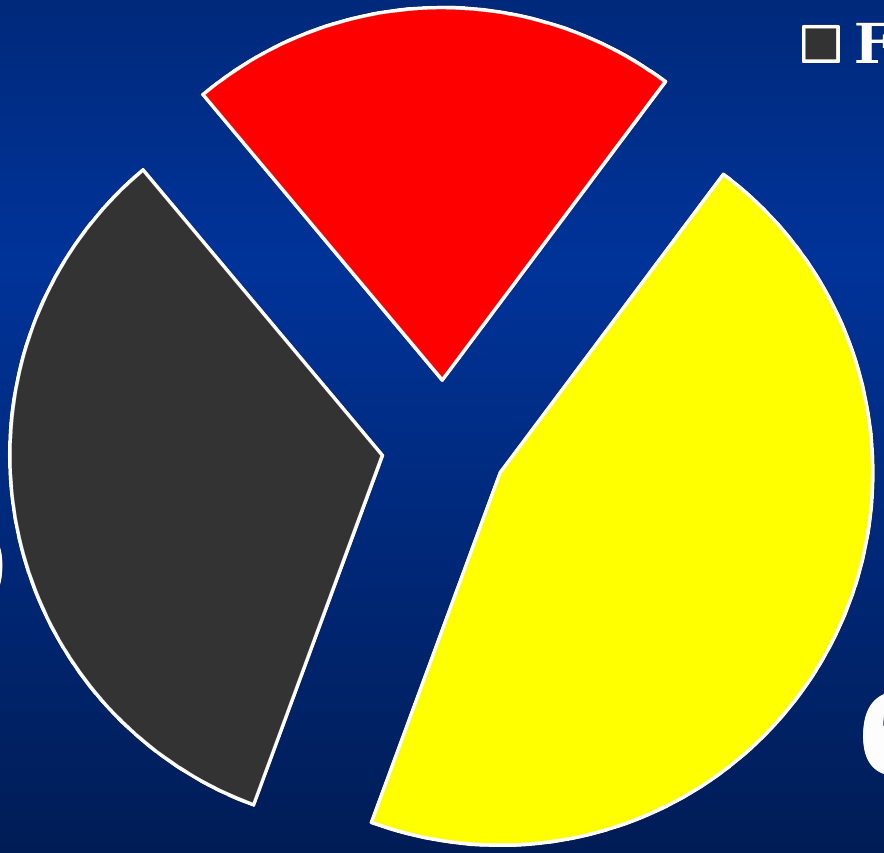
Gage Height (ft)



Time

USGS

Summary of Hydroacoustic Instruments



USGS

July 2006

New developments in hydroacoustics

USGS

OceanScience High-Speed Boat

USGS

7 Slow-speed boats in use in USGS

RC Boat - SeaRobotics

USGS

Semi-Autonomous Controlled Boats

USGS

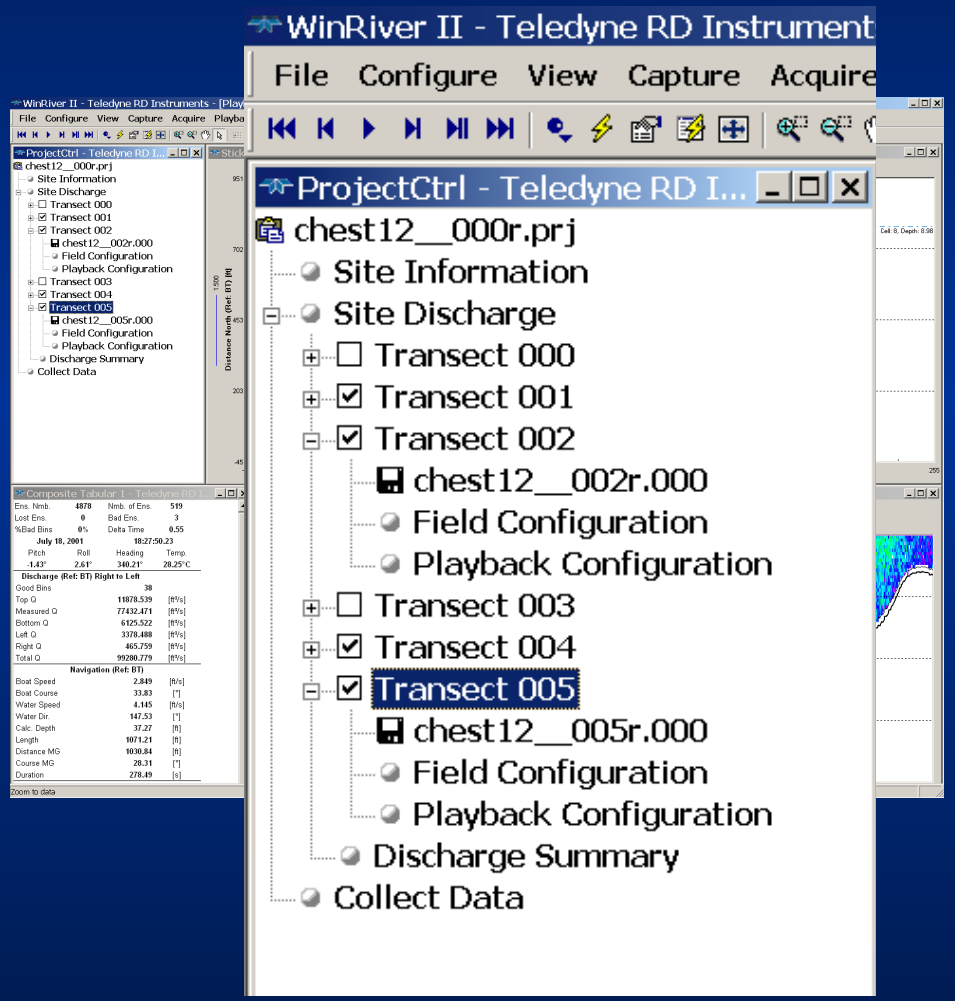
Next Generation ADCP

- Integrated system
  - ✓ Compact 600kHz Phased Array Transducer
  - ✓ New compact, low power electronics set
  - ✓ Bluetooth wireless comms
  - ✓ More automated, wizard-based software
  - ✓ Trimaran float, 10-18 VDC
  - ✓ External options: DGPS, depth sounder

USGS

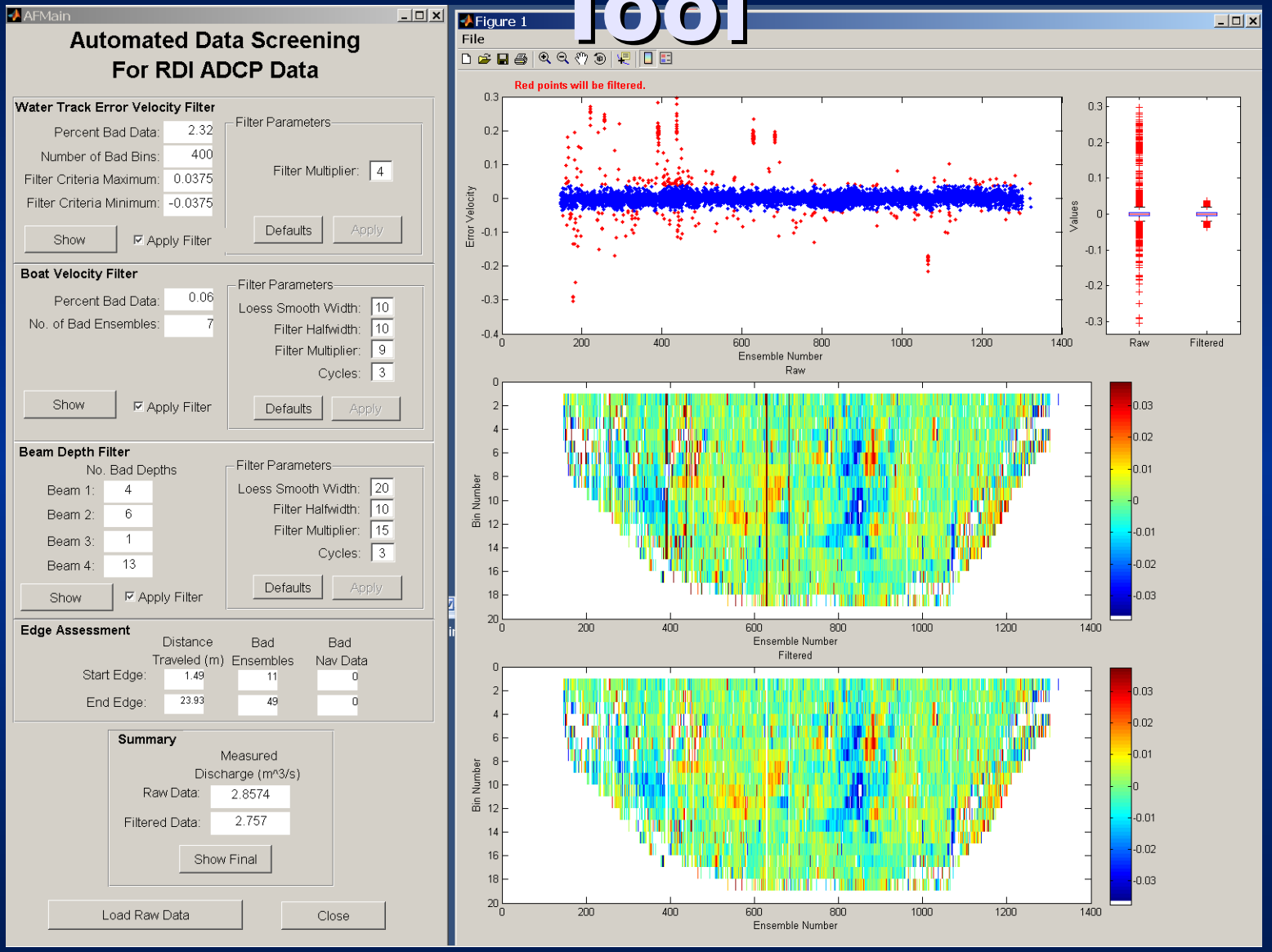
WinRiver II

- New user interface - Site-centric design
- Improved configuration wizard supplied by USGS
- Automated data analysis supplied by USGS
- Improved handling of GPS
- Support for section by section Qm's



USGS

Automated Data Screening Tool



USGS

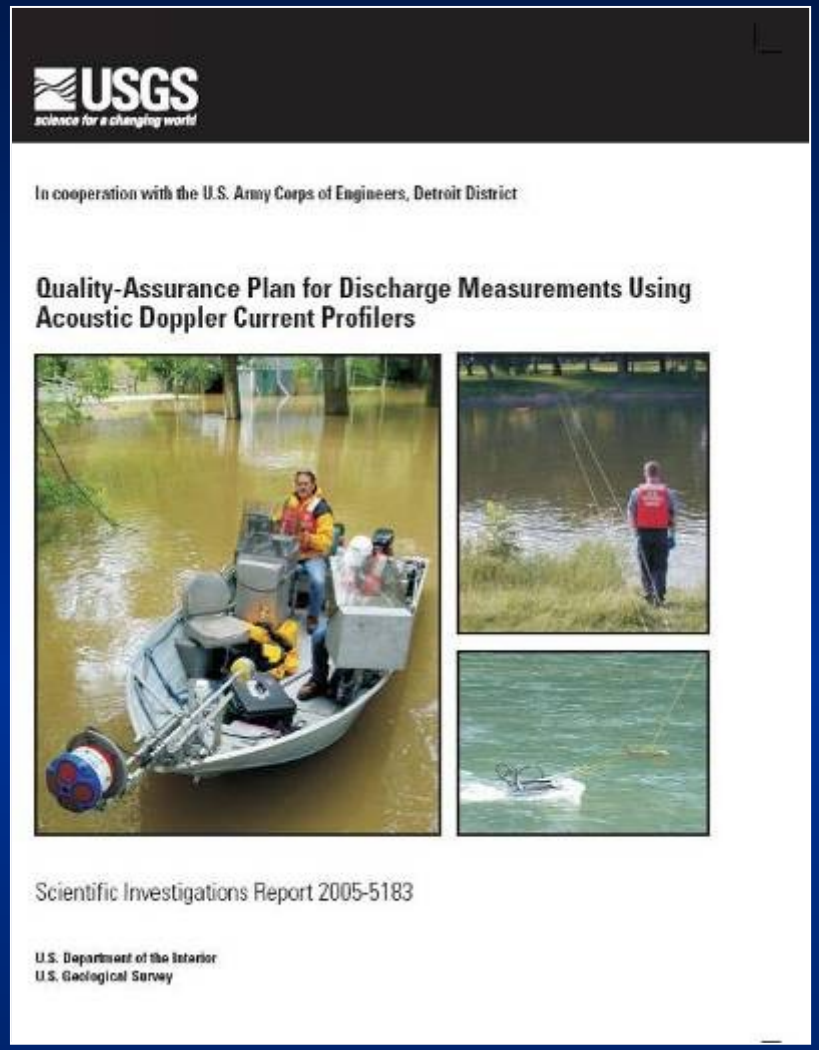
Quality Assurance

USGS

QA of ADCP Measurements

New information:

- **Criteria for moving bed tests**
- **Temperature measurement**
- **Detailed procedures for Qm's**


USGS
science for a changing world

In cooperation with the U.S. Army Corps of Engineers, Detroit District

Quality-Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profilers

Scientific Investigations Report 2005-5183

U.S. Department of the Interior
U.S. Geological Survey

http://pubs.usgs.gov/sir/2005/5183

USGS

Quality Assurance is Important!

USGS

OSW Technical Training

- ✓ Streamflow Measurements using ADCPs
- ✓ Advanced ADCP Applications
- ✓ Index Velocity Measurements and Ratings

http://il.water.usgs.gov/adcp/training/

USGS

OSW Technical Memos

2000.03	Mandates use of WinRiver
2002.01	Configuration of RDI ADCP's
2002.02	Policy on ADCP Qm's
2002.03	Release of WinRiver 10.03
2003.01	Discharges computed using SonTek RiverSurveyor
2003.04	Release of WinRiver 10.05
2005.04	Release of WinRiver 10.06
2005.05	Guidance on use of RDI StreamPro
2005.08	Archiving ADCP Discharge Measurement Data
2006.02	Quality Assurance Plan for ADCP Qm's
2006.xx	Moving Bed Test Procedures and Corrections
2006.xx	Calibration of ADCP's used for Discharge Meas.

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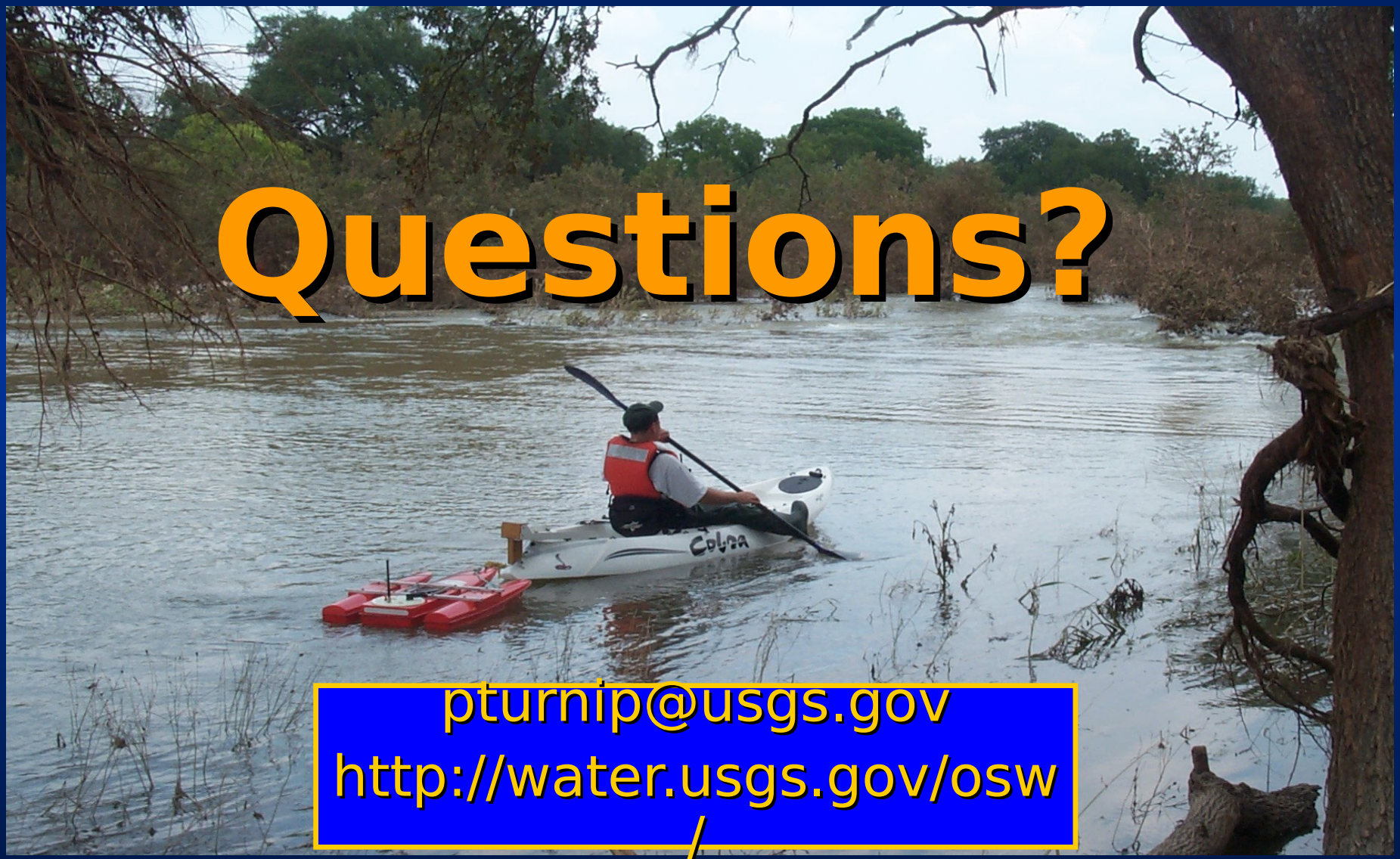
Questions?
pturnip@usgs.gov
http://water.usgs.gov/osw/